MICROWAVE MEASUREMENT OF COTTON LINT MOISTURE

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Abstract

A microwave moisture measurement technique was developed for moisture sensing of cotton bales after the bale press. The technique utilizes the fundamental principal of electrical permitivity measurement, in free space, of cotton lint at various densities. This sensors provides a reliable non-contact measurement of the moisture content and can be utilized to provide feedback for moisture restoration systems.

Introduction

Currently there is a movement within the ginning industry to utilize moisture restoration systems. This is in part due to the fact that optimal control of the moisture content will produce greater economic returns for a given ginned bale of cotton as well as reduce the press box force required to press the cotton. This is advantageous, as numerous gins have reported lower breakage rates when utilizing such systems. In this regards, this research was conducted to develop better and lower cost sensors for use in moisture management in the cotton gins for future cotton gin automation. Gin automation is desirable as it will lead to an increase in the net economic yield for the grower, and will also help to reduce ginning costs (Anthony, 1990).

This paper presents fundamental research to determine the dielectric properties of cotton lint as a function of moisture content.

Procedure

Cotton bales that had a wide range of moisture contents as well as a wide range of bale weights were obtained this study by manipulating a moisture restoration system. The bales ranged from 3.8 percent moisture content to 8.3 percent moisture and the bale weights ranged from 330lbs to 550 lbs. All bales were weighed both before and after the test. Multiple samples were obtained from each bale for moisture content determination.

The bales where then placed between two microwave horn antennas that were constructed and tuned to the center frequency of the desired measurement. Each horn was then placed inside an anechoic tube of microwave absorbing material to remove the effects of multi-path interference from the measurements. Then scattering complex transmission coefficient “S” parameter microwave impedance measurements were then taken over the range of frequencies from 1.0 GHz to 2.5 GHz of both the samples and also of an air reference, before each measurement, to remove the effects of the environment, cables, antennas and instrument effects from the sample

measurement. The measurements were taken with a Hewlett Packard 8753D Network Analyzer with high quality coaxial cables (this does not constitute an endorsement by the USDA for this product).

Results

The test results indicated that it is both possible to measurement the combination of mass times the moisture content, in effect a moisture density, as well as to determine the moisture independently as well as the density independently. These results show promise for future developments. The results illustrated at this time reflect a correction for the bale weight as that provides the most accurate measure of moisture utilizing this technique (figure 1) (standard error of less than ½% moisture content).

Summary

This research revealed the strong dependence of the cotton lint's permitivity to the moisture content and bulk density of the cotton bale. The experiment was setup with a wide range of these variables in order to provide as wide a range as possible in order to determine the effect each parameter has on the sensing technique.

An algorithm was developed to utilize the bulk weight of the cotton bale in which to predict the moisture content from the free space microwave measurement. These preliminary results indicate a high degree of repeatability as well as an accuracy that is at least as good as the known accuracy of oven based moisture determination.

References

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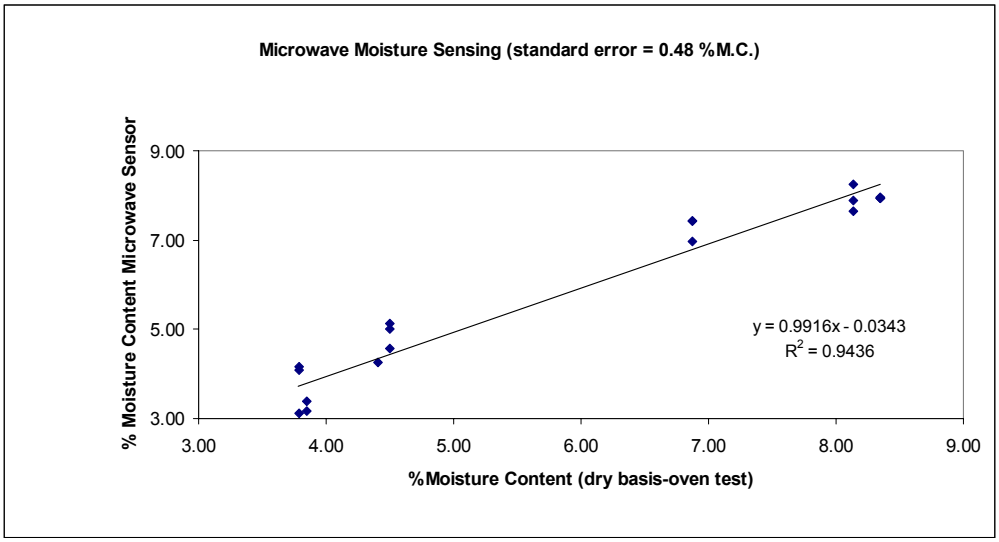

Figure 1. Microwave moisture content determination.